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TUBERCULOSIS.

WITH SPECIAL REFERENCE TO ITS EPIDEMIOLOGY, TRANSMISSIBILITY, AND PREVENTION.

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Tuberculosis has been aptly spoken of as "the great white plague," and its ravages may be appreciated when we recall that, in spite of marked progress in preventive efforts, this disease carried off during the year 1913 over 143,000 victims in the United States alone. If we accept Dr. Phillips's estimate that for every death from tuberculosis there are 10 cases of the disease, the number of persons afflicted in this country would be 1,430,000. If we accept the most conservative estimates offered on this point—viz, 1 per cent of the population—the number of consumptives would be 987,813. The average duration of a case of tuberculosis is about three years, and the cost of medical attendance, food, nursing, and loss of work during this time has been estimated at \$2,240; but taking a most conservative basis and calculating only \$1,500 for each death, the 143,000 deaths represent an annual cost of \$214,500,000 to the people of the United States.

A Hopeful Problem.

Great and grave as the problem may appear, there is certainly hope when we recall the fact that the death rate from tuberculosis has apparently been reduced from 326 per 100,000 in 1880 to 147.6 in 1913, which means that if the former rate of mortality had been continued the number of deaths from this disease last year would have been 322,027 instead of 143,000. This is equivalent to a saving of 179,027 lives during 1913 from this disease alone.

While much has been accomplished, more remains to be done before we can hope for the eradication of this preventable disease.

The Cause and Spread of Tuberculosis.

The classical researches of Koch in 1882 established beyond doubt that the disease is caused by microscopic organisms, which, upon entering the living body, are capable of rapid multiplication, and by irritation cause the growths known as tubercles. The presence of these morbid growths constitutes the disease called tuberculosis, which may affect not only the lungs, but other structures of the body as well.

The disease is communicable from man to man, from animal to man, and from man to animal. The transmission always takes place through the agency of the specific germs which emanate from a previously diseased body and enter a new host. The most frequent portal of entry or path of infection for the tubercle bacillus is doubtless by inhalation of bacilli-laden dust or air. It is perfectly conceivable that the expectoration of consumptives on floors, clothing,

etc., soon becomes dry and pulverized and, as a constituent of atmospheric dust, may be inhaled. It has also been demonstrated by Flügge that a consumptive with an active expectoration, in coughing, talking, or sneezing, projects into the air little droplets of saliva laden with tubercle bacilli, which can be inhaled within 3 feet from the patient. These droplet infections, according to Flügge, and in the opinion of the writer, constitute the most dangerous form of transmission and account for the so-called family infections which are so frequently observed, especially in small homes.

The reason why droplet infection is especially virulent is that the bacilli enter the respiratory passages in a fresh state without prolonged exposure to light and desiccation, which would tend to diminish the virulency of the germs. Both of these modes of spreading the disease can be prevented by the collection and proper disposal of the sputum, by avoidance of close contact, and insisting that a consumptive guard his mouth and nose by means of a handkerchief while talking, coughing, or sneezing. This is especially important in close contact.

Infection Through the Digestive Tract.

In our present state of knowledge the next most frequent portal of entry of the germs is the digestive tract. Here, again, let us refer to the sputum on floors or carpets carelessly expectorated by consumptives or tracked in on the shoes and formerly on long-trained skirts. What is to prevent a child creeping on the floor from soiling its hands and carrying the infectious material to its mouth as long as we permit careless and unteachable consumptives to expectorate promiscuously? In this connection we should also emphasize the danger from kissing, and the common use of eating and drinking utensils, through which the infection may be transmitted by the small but virulent particles of sputum adhering to the lips of consumptives. The danger from these sources has been recognized, and ordinances have been enacted forbidding spitting in public places and the common use of drinking cups. But should we not also insist upon provisions for cuspidors and individual drinking cups or fountains? How many public buildings and schools are thus supplied?

Danger from Bovine Tuberculosis.

In addition to the danger from human sources we can not ignore the danger of transmission of bovine tuberculosis through the agency of infected milk and meat. The danger from cooked meat is quite imaginary, since exposure to a temperature of even 140° F. for 20 minutes suffices to kill the germs. The degree of danger from raw tuberculous meat remains to be determined, although we have records of cases where butchers and veterinarians have been inoculated with tuberculosis from infected meat through wounds and abrasions of the

skin. In passing, it should be stated that similar infections are possible in cleaning cuspidors.

The danger from tuberculous milk, however, is real and can not be ignored. The Public Health Service, in examining 272 samples of milk from 104 dairies in the city of Washington, found tubercle bacilli in 6.72 per cent of the samples. The danger from this source is therefore especially great during the milk-drinking age, and probably accounts in part for the prevalence of tuberculous meningitis and of tuberculosis of the lymphatic glands, joints, and bones during infancy and childhood.

There is much reason for believing that bovine tuberculosis is at least responsible for the majority of affections formerly spoken of as scrofulous. There may also be a certain amount of danger from infected dairy products like cheese and butter.

Recent post-mortem examinations conducted by Hamburger and Monti in the Vienna hospitals show that 95 per cent of the children who came to autopsy, largely the children of the poorer classes, were already tuberculous by the time they reached the twelfth to thirteenth year of life. Just how much of this almost universal infection is due to bovine origin and how much to the human sources of danger remains to be determined. Von Behring holds that in the great majority of cases of pulmonary tuberculosis the primary infection dates back to infancy and childhood, and is derived from the milk of tuberculous cows.

While it is true that there is a special danger from infection in children, which may remain dormant until the period of adolescence and maturity is reached, the author is not prepared to accept the view that infectious cow's milk is the primary and most important source of infection, in spite of the fact that he was one of the first to emphasize the danger of infected cow's milk. His reason for not accepting von Behring's dictum is that the bovine type of tubercle bacilli is rarely found in pulmonary consumption. It was not found in a single case in the 277 autopsies of pulmonary tuberculosis in children reported by Dr. Wm. H. Park. It is claimed that there is a possibility of the transformation of the bovine into the human type of the bacillus by prolonged survival in the human body; that may be true, but remains to be proven. In the meantime we know that the human type was found in 388 autopsies and the bovine type in only 24, or 5.82 per cent, of 412 autopsies. It is not desired to underrate the danger from this source. By all means let us continue our efforts toward the ultimate extermination of bovine tuberculosis, and until this is accomplished, let us pasteurize, or at least scald, our milk, but let us not forget that in the light of our knowledge and experience the greatest source of danger in the transmission of pulmonary tuberculosis is the human patient, just as in other communicable diseases.

Childhood Not the Only Danger Period.

In this connection it may be well to caution against accepting the belief at times advanced that childhood is the time of infection and that to the adult there is little if any danger of infection from outside sources.

While it is true from the observations of Humphrey, Pollock, Leudet, and others, that it is rare for the disease to be contracted by physicians, nurses, and others connected with hospitals for consumptives, the results are different in private practice and life.

Uffelman in his *Handbuch der Hygiene*, 1890, cites the results of a French committee of investigation, who reported 212 cases of tuberculosis, in which the communicability of the disease was clearly established. In 64 of these cases the disease was conveyed from husband to wife; in 43 from the wife to the husband; in 38 it was transmitted to brothers or sisters; in 19 from parents to the children; in 16 to distant relatives and in 32 to persons not relatives of the family. The communicability was most marked among the poorer classes. Another collective investigation by a German medical society, cited by Uffelmann, revealed the fact that of 938 married persons, who died of acquired tuberculosis, in 101 instances either the husband or wife also contracted the disease. Uffelmann also cites Meyerhoff's statistics in private practice dealing with 40 cases.

Other statistics might be adduced in favor of the communicability of the disease, but Zasetzky's observation is of special interest. He reports the case of a tuberculous woman who married between 1872 and 1883 three husbands, all previously healthy. The first husband died of tuberculosis in 1879, the second in 1881, and the third husband at the time of the report in 1884 was also a victim of the disease, the wife having in the meantime died of consumption.

Infected Clothing.

There is some reason for believing that the germs of tuberculosis may be conveyed in clothing. Perlen, in his dissertation on pulmonary consumption and occupation, tells us that of 4,177 tuberculous patients treated at the Munich Poliklinik, 709 were engaged in renovating clothing and footwear. While these figures are suggestive, it is of course impossible to determine the number of instances of direct infections.

Agency of Flies in the Transmission of Tuberculosis.

The possibility that the germs of tuberculosis may be carried by means of flies and dust suggests that greater precaution be exercised in the exposure of foodstuffs in the homes and also in show windows and markets, and that an effective antily campaign be carried on. Other modes of infection, such as by the mucous membranes of the

eye, genitals, wounds, and even through the unbroken skin, have been reported

There is little or no evidence to show that the disease is ever inherited. We may assume, however, that in children of consumptive parents we are dealing with the transmission of vulnerable anatomical elements, and this, together with the fact that children are constantly exposed in tuberculous families to the germs, renders them particularly liable to the disease.

Tuberculosis Almost a Universal Infection.

Recent investigations tend to confirm the conclusions long since enunciated by a German physician that "in the end everybody has a touch of tuberculosis." At all events, Nageli, in 1900 found that 97 per cent of adults examined at autopsy in Zurich showed active, latent, or healed tuberculosis. This, of course, in the language of Prof. Welch, is "not equivalent to saying that everyone has or has had the disease tuberculosis. It signifies merely that in the class of people examined practically everyone had received into the body tubercle bacilli and that these had left their record behind."

From what has been said it is evident that tubercle bacilli are widely scattered. The modes of invasion are also numerous, and yet there is a certain proportion of those exposed who do not develop the disease. This shows, as already mentioned, that in addition to the germs there must be a suitable soil for the growth and destructive effects. Such a soil is usually found in persons of feeble physique, victims of malnutrition, whose bodies have been weakened by one or more of the numerous causes, whether it be a previous attack of sickness, loss of sleep, overwork, vice and dissipation, insanitary homes, impure air, or lack of cleanliness, sunlight, outdoor exercise, or proper food.

Clinical experience indicates that faulty nutrition, debility, loss of blood, anemia, mental anxiety, diabetes, whooping cough, measles, and other diseases favor the development of tuberculosis. We also know that a predisposition may be inherited, as evidenced by a delicate physique, narrow chest, and general vulnerability of the tissues. Predisposition to tuberculosis may also be acquired through dust-producing occupations, and here the amount of dust is less important than the character of the particles which compose it.

The Influence of Dust.

The influence of dust on the prevalence of the disease is strikingly shown by the fact that the tuberculosis rate among 472,000 males in the United States, exposed in 15 occupations to the inhalation of organic dust, was 2.29 per 1,000, against a rate of 1.55 for all occupied males, and also by the fact that 42.05 per cent of the deaths

of printers, lithographers, and pressmen, who died at ages between 25 and 44 years, were from consumption, as compared with 21.88 per cent for farmers, planters, and overseers. Statistics collected by Sommerfeld show that with an average tuberculosis death rate of 4.93 per 1,000 in the population of Berlin, the rate in nondusty trades was 2.39 and in dusty trades 5.42.

The explanation of this is to be found in the fact that dust acts as an irritant and causes catarrhal conditions of the mucous membranes and even more serious chronic inflammation of the respiratory organs. The chronic inflammatory conditions thus produced naturally favor invasion of the tubercle bacillus, or may light up a latent infection contracted in early life.

The influence of dusty trades is strikingly illustrated in the State of Vermont. In analyzing the statistics of the towns where most of the granite and marble cutting is carried on, we find in a combined population of 34,899 a tuberculosis rate of 2.2 per 1,000 against a rate of 1.3 for the entire State.

It is estimated that our industrial workers, constituting about one-third of the population, contribute about one-half of all the deaths from tuberculosis in this country, and that by factory sanitation and effective methods for the prevention and removal of dust, fully one-half of these lives could be saved. This is not all speculative, since Prof. Röpke has shown that the mortality of Solingen in Germany, the population of which is largely made up of employees in the cutlery industry, has been reduced from 20.63 per 1,000 in 1885 to 9.3 per 1,000 in 1910, and the tuberculosis death rate from 5.4 in 1885 to 1.8 in 1910 per 1,000 of population. Similar data are available to show that diseases of the respiratory organs in some of the German cement works have been reduced from 9.3 to 3.3 per cent after the installation of a suitable apparatus for the removal of dust.

What can be done in some of the most dangerous industries in Germany can be done in this country, and will be done as soon as the importance and feasibility of the subject are fully appreciated.

Influence of Damp Soils.

The observations of Drs. Bowditch of the United States and Buchanan of England, in the sixties, indicate that damp soils and damp houses are important predisposing causes of tuberculosis. We also know that with the introduction of sewers the mortality from the disease has been reduced in numerous cities from 30 to 40 per cent. The only reasonable explanation is that the introduction of sewers indicates a general improvement in living conditions, especially of the air we breathe, and also renders otherwise damp soils and habitations dry and more healthful.

Insanitary Houses.

The influence of insanitary dwellings on the prevalence of tuberculosis is very great. Where the sun does not enter the physician surely will. Dark, gloomy, and damp houses should be avoided. Moldy spots on the walls or ceilings and a close, musty odor indicate dampness. It has long been known that tuberculosis is far more prevalent in damp, dark, and insanitary houses. The children there are anemic and as puny as plants reared without the stimulating effects of sunlight. The death rate is often double and treble that of other homes. It should be remembered that the tubercle bacillus clinging to the floor and walls in carelessly expectorated sputum or droplets would be destroyed by a few hours of exposure to sunlight, but finds in dark and damp tenements suitable environments for its vitality and growth.

We have heard of the notorious "lung blocks" from Drs. Biggs of New York and Flick of Philadelphia. Among the 80,000 houses in the city of Paris, according to Marié-Davy, there were 4,443 with an unusually high mortality rate; in 820 of these the mortality from tuberculosis was 9.8 per 1,000, as compared with 4.5 per 1,000 in the general population. The cause was attributed to overcrowding, deficient ventilation and defective light, especially lack of sunlight. The other concomitants of poverty were probably also present.

The writer has no hesitation in declaring that the housing conditions of the least resourceful people have been and are even now a most important factor in helping to swell the frightful mortality from consumption and other so-called house diseases, engendered by unwholesome environments. The State may not be in a position to provide sanitary houses, but it can at least regulate and supervise the construction of all new houses with reference to air space, light, ventilation, etc., and enact laws for the condemnation of houses unfit for human habitations.

Influence of Parks and Breathing Spaces on the Prevalence of Tuberculosis.

Wernicke in his Monograph on the Relation of Disease and Social Conditions, points out that in London, where the parks and unoccupied area of the city available for breathing spaces amount to 14 per cent, the tuberculosis death rate is 1.9 per cent; in Berlin with 10 per cent of the city area available for breathing spaces it is 2.2 per cent, and in Paris with only 4.3 per cent of open spaces, the death rate from consumption is 5.1 per cent.

Such data constitute a strong argument for the establishment of sanitary schools, especially in view of the experience with fresh-air schools which have everywhere furnished encouraging results.

The State should not only provide sanitary schools, but also an abundance of parks and playgrounds, and should pay special atten-

tion to the physical development of the young. This is important for all classes, and especially for children of consumptive parents on account of the transmission of vulnerable anatomical elements, which render them peculiarly liable to the disease. This predisposition may certainly be overcome by pure air and physical culture in addition to proper food. If it be found that school children are starving for the want of proper food, it is clearly our duty to make suitable provisions to prevent permanent dependency. In brief, no effort should be spared to increase the resisting power of the individual to disease.

Preventive Measures.

The facts presented justify the following conclusions:

1. Tuberculosis is an infectious disease caused by a specific organism. An inherited or acquired predisposition plays an important rôle.
2. There is reason to believe that infections may occur at all periods of life and that the disease may remain quiescent until some debilitating factors lighten up these latent infections.
3. The germs may enter the system by the respiratory and alimentary passages and even by the skin and mucous membranes if there be an abrasion.
4. While the bacillus may be transmitted through the milk, flesh, and blood of animals and man, the most common and effective way of disseminating the tuberculosis is by the sputum and droplets of tuberculous patients.

5. The habitations of consumptives, their personal effects, clothing, bedding, etc., are infected and liable to convey the disease to others.

From what has been stated it is evident that the prevention of the disease should be the central object of the campaign. For this purpose popular education, which not only emphasizes the cause and means of spread of the disease, but also the improvement of the general health of the people, thereby increasing the resisting power of the individual to the ubiquitous tubercle bacillus, is of the utmost importance. The writer is confident that the value of health talks is especially great for school children. When we supply our children with healthful schoolrooms and teach them the value of pure air, sanitary homes, proper and sufficient food, physical culture, baths, and suitable clothing, and the importance of temperance and pure and clean lives, the lessons taught will be applied in the homes and workshops of the Nation. Such a plan should be supplemented by annual medical examinations for the recognition of incipient cases. No opportunity should be lost in the general campaign to spread the gospel of personal hygiene, and general sanitation, for be it remembered that every movement which makes for better health and a temperate, untainted, and virile race will offer the best safeguard in the prevention of tuberculosis.

State Methods of Prevention.

Special emphasis has been given to the prevention of the predisposing causes of consumption, and it is equally important to point out the State methods for prevention.

1. Compulsory notification of cases to the health authorities as soon as the disease is recognized. This is of vital importance for the location and control of the sources of infection and for the protection of the family and others. The health authorities, apart from distributing printed directions for the use of the family and the patient as regards the care and disinfection of sputum and the avoidance of droplet infection, should also resort to disinfection of the home and personal effects, especially upon the death of the patient or vacation of the premises. The patient when outdoors should use a pocket sputum flask, and during coughing, sneezing, or talking should guard his mouth by means of a handkerchief.

2. The enactment and enforcement of laws against promiscuous expectoration, coughing into the faces of persons, and the common use of drinking cups are called for. Provisions should be made for drinking fountains or individual drinking cups, and for suitable spittoons and their disinfection in all public buildings. The public should not cultivate an exaggerated fear, but has a right to insist upon clean and decent precautions.

3. The sanitary conditions of hotels, lodging houses, theaters, churches, schools, and ambulance and passenger service should be under the control of the health department, and house cleaning should be accomplished as far as practicable by the vacuum system.

4. Marriage with a tuberculous person should not only be discouraged, but prohibited by law. A tuberculous mother should not nurse or kiss her infant, and in the selection of a wet nurse a certificate of health should be demanded.

5. In hospitals, asylums, and similar public institutions isolation of tuberculous patients should be insisted upon. In private life the patient should occupy at least a separate bed, use separate eating and drinking utensils, and neither receive nor give kisses.

6. Inspection of dairies and of dairy and meat products and the extermination of bovine tuberculosis are called for. Until the latter is accomplished milk and cream should be heated to 140° F. for 20 minutes, cooled quickly and kept cold, and all meats should be cooked.

Provisions for the Care and Treatment of Consumptives.

Tuberculosis dispensaries should be established in all cities and towns and at convenient places for rural areas. The object of these dispensaries is the recognition of the early cases with a view of prompt treatment for incipient cases. If the patient is unable to

pay for treatment, it is clearly the duty of the community to carry the burden. The expense of such agencies should not rest upon the shoulders of a few, unless men and women with sufficient means can be found to carry on the work effectively. When for any reason circumstances compel home treatment, a course which should always be discouraged in the poorer classes, it is essential that a visiting nurse be employed to insure sanitary oversight of the home, proper food, and faithful execution of the physician's directions.

Sanatoria and Hospitals.

There are now in the United States 550 sanatoria hospitals and day camps with approximately 35,000 beds devoted to tuberculous patients. There are over 400 dispensaries with over 1,000 physicians in regular attendance. A corps of about 4,000 visiting nurses is engaged exclusively in tuberculosis work. Probably in the majority of incipient cases the disease is arrested and those who have the means to care for themselves remain cured. It must be admitted, however, that 75 per cent of those discharged as apparently cured, when obliged to return to bad social and industrial conditions suffer relapses and finally die of the disease. Such a sad termination might be prevented by the establishment of working farms or colonies, improved living conditions, or change of work. Much of this involves great social reforms, which may not be attained for many years. In the meantime let us see to it, by educational methods at the sanatoria, that the discharged patient is properly informed how to care for himself even under adverse surroundings.

Hospitals for advanced cases.—The leaders in the antituberculosis movement have long since realized that the advanced and helpless cases are the most dangerous sources of spreading the disease. They have reached the conclusion that the segregation of these advanced and expectorating cases in hospitals "far outweigh in preventive value all others." For this purpose we need special hospitals or at least special pavilions if connected with a general hospital. The duty clearly devolves upon the State. The next question arises, How many hospitals and beds for advanced cases are needed? This depends upon the number of deaths and the prevalence of the disease in a given community.

Of the 143,000 deaths in the United States, we may assume that possibly 25 per cent are in families which can afford the expense of separate rooms, special nurses, and other safeguards at their homes, leaving an average of 117,250 patients to be cared for in hospitals. The average stay of an advanced case is about 110 days, which enables each bed to be used for three patients a year; hence we may conclude that about 35,000 beds for advanced cases alone are needed

which is our present capacity for all classes of patients. The original cost of construction and equipment need not exceed \$1,200 per bed, and the cost of maintenance is about \$10 a week. This sum, high as it may appear, is trivial in the face of the present economic losses from this disease. Apart from this it is the only humane way to relieve the families with small incomes of the burden of caring for their helpless sick and is at the same time a most effective measure in the prevention of the spread of the disease.

Moreover, with the segregation of the advanced cases it may be confidently expected that there will be a steady diminution in the number of cases to be cared for and a corresponding decrease in the annual expense.

There are at present over 2,500 special agencies, including about 1,200 State and local antituberculosis associations engaged in the warfare against the great white plague, and it is to be hoped that, in view of the progress which has been made since 1880, this scourge may be very materially further reduced if not exterminated before the close of the present century.